



Scalable Health Intervention Evaluation (SHINE) for Better Public Health Policy: What is it? And how do I use SHINE?

Next generation simulation infrastructure being built at the University of Melbourne

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1



Who are we?

Population Interventions Unit (PI)

Stream 1: Causal inference and natural experiment methods

- Potential outcomes and counterfactual approaches
- Natural experiments and econometric approaches



Stream 2: Epidemiological and economic simulation

- SHINE: Scalable Health Intervention Evaluation
- Estimating intervention impacts on health gain, health expenditure income

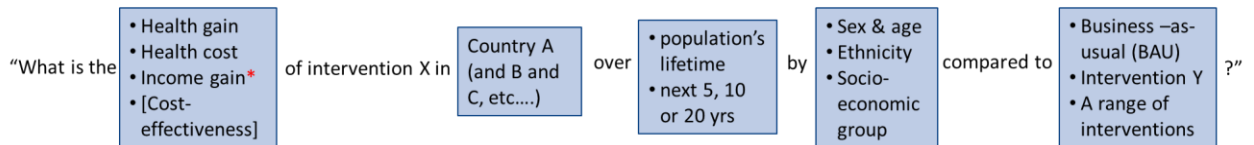
Methodological innovation

Platform: Australasian and international collaborations and data sharing

2



What we really want is a platform that can answer (rapidly and comparably) any question of this type



3

3



Key informant interviews with 16 senior Australian policy makers in early 2020

Reactions to SHINE included:

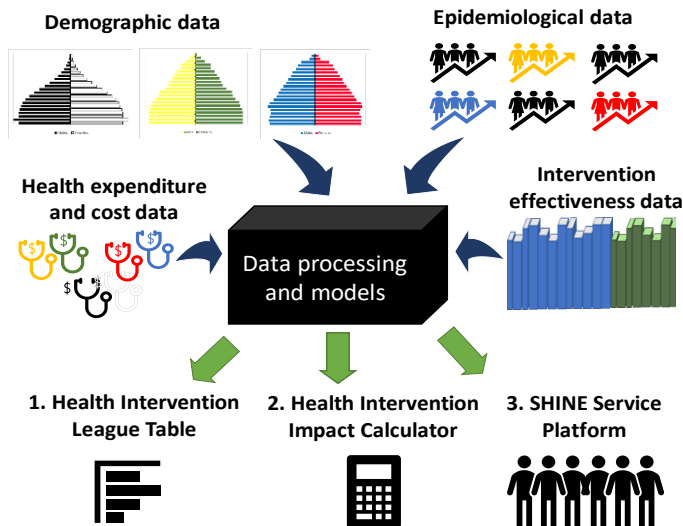
- “If we can nail what is the most effective intervention, then in some ways you have hit the Holy Grail”
- “...[There is a] lack of information that can turn dollars into actual human benefits, and back again, and that is where this [project] could be a very useful contribution”,
- “... Bringing epidemiology and economics together is currently a very sweet spot”.

4

4



How does SHINE work?



5



What's inside the "Data processing and models" black box ?

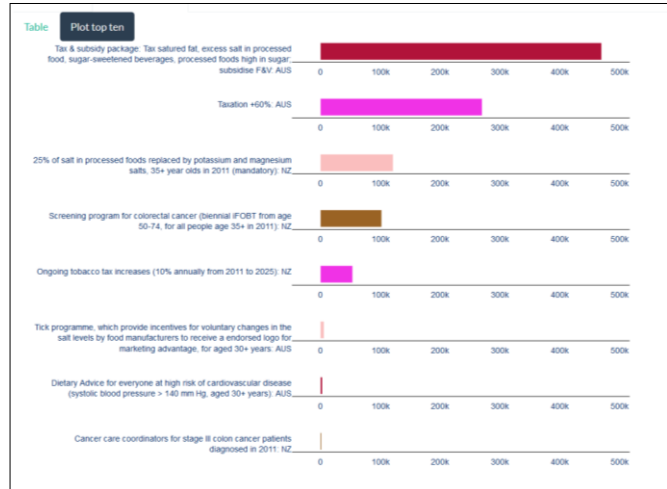
1. Proportional Multistate Lifetable Model
 - A master lifetable, and as many disease sub-lifetables needed for the intervention (e.g. 16 key tobacco related diseases)
 - All lifetables populated with current and forecast:
 - epidemiological data (AIHW, Institute of Health Metrics and Evaluation – home of GDB, collaborator on SHINE)
 - health expenditure data by disease → cost offsets
 - income loss by disease → productivity gains
 - An intervention model (below) generates a change by sex, age, time and sub-population of one or more of disease incidence, morbidity, case fatality and costs → changes in HALYs and total costs
2. Suite of intervention models
 - Examples include:
 - tobacco tax → change in smoking → change in disease incidence;
 - our COVID-19 agent-based model (used by Victorian Govt to underpin Vic's exit from its 2nd wave to elimination of transmission) is a 'special' example

6



Australia NZ-Health Intervention League Table (ANZ-HILT)

"...which everyone, **everyone**, **EVERYONE** needs...." <https://league-table.shinyapps.io/bode3/>



7

7



The Health Intervention Impact Calculator (HIIC; under development)

Risk factors, population

Risk factor(s)

- Tobacco
- Sodium
- Body mass index
- Blood pressure
- [ideally, all GBD risk factors]

Population

- Country or countries
- Sub-population options within country:
 - Sex and age (obligate)
 - Ethnicity/Indigeneity
 - Socioeconomic strata
 - Urban/rural

Structure

Discount rate

- 0%, 3%, 6%

Base-year

- Calendar year

Time horizon

- Remaining lifetime
- 0-10 years post base-year
- 11-20 years post base-years

Intervention specification (A or B) †

A. Δ risk factor(s)

- Absolute or % Δ option
- Pattern of risk factor change:
 - Base-year only; Permanent; Exponential decay; Other
- Time lag from Δ risk factor to Δ disease incidence
 - Default; User-specified

B. Δ incidence rates for each disease

- Absolute or % Δ option
- Pattern of risk factor change:
 - Base-year only; Permanent; Exponential decay; Other

Intervention cost

- User-inputted for population, by year in time horizon

Outputs

Metrics

- Δ HALY
- Δ net health expenditure
- Δ income (productivity)
- Other (e.g. morbidity rates, HALE)

Heterogeneity

- By sex and age
- By user-selected sub-population

Timing

- Over remaining life time
- By 10 year epoch post base-year

8



SHINE will allow more rapid and comparable modelling, and scalability

- Automation of simulation infrastructure
- Ability to link more easily to global and Australian datasets
- Platform for others to use
- Ability to update evaluations annually, and/or as data on input parameters improves
- And scaling up, out and down....



9

9



Where is SHINE at now? (Nov 2021)

- Predecessors ACE-Prevention and Burden of Disease Epidemiology, Equity and Cost-Effectiveness program (BODE³; NZ; I directed 2010-19) have laid foundations for SHINE
- SHINE has converted old Excel models into Python for use on Uni Melb super computer
- We have a growing team at Uni Melb (simulation modeler, epidemiologist, econometrician, clinical epidemiologist ... plus many more), and collaborations at Deakin and Otago Unis
- We are part of two NHMRC Centres of Research Excellence in Housing and Tobacco, feeding in interventions to evaluate. We are currently applying for multiple other grants.
- We have a body of COVID-19 work completed:
 - Influential Agent Based Model that underpinned Vic RoadMap, and → best options (under review)
 - Asia Development Bank contracts for ABM and PMSLT modelling in Armenia and Pakistan
- We are 'open for business' to engage with commercial clients and research collaborators

10

10

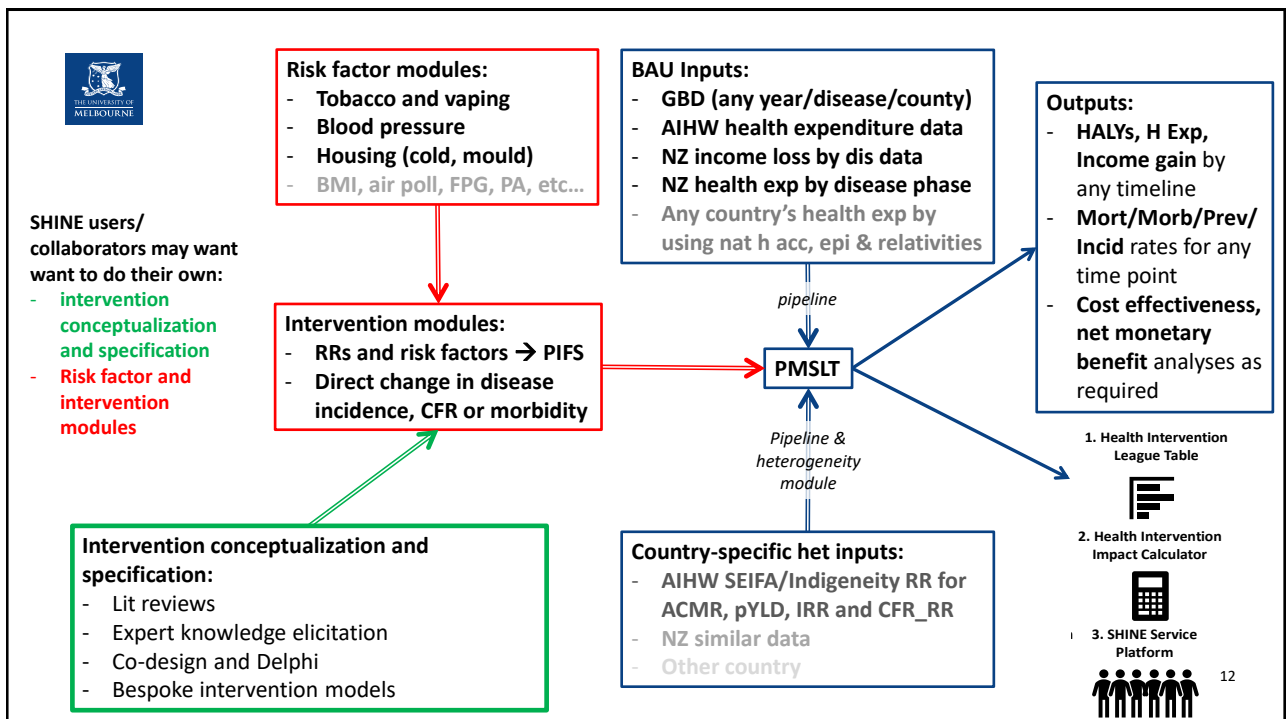


How SHINE works

- The next slide gives a schematic overview
- The minimum parts of SHINE that clients and collaborators would want to use is that in **blue** on the right.
- Some collaborators and clients may want to do their own:
 - Risk factor modelling (**red** on next slide)
 - Intervention conceptualization, specification and modelling (**green** on next slide)
 ... and feed in their outputs as inputs to our core PMSLT modelling
- SHINE can also do all components shown in the next slide.

11

11



12



SHINE-user case study 1

- A research team has spent years quantifying the impact of urban design interventions on air pollution, with BAU and intervention forecasts of exposure
 - *They use SHINE to generate the expected stream of HALYs, H expenditure and income changes, by decade into the future*
 - *More: The team also has data on noise levels and changes in PA patterns – they work with the SHINE team to capture all health impacts*
 - *More still: The State Government has provided costing estimates for the interventions – the research team works with SHINE to undertake a partial (health outcomes only) cost effectiveness study*
 - *Even more: Research Group B or the State Government are undertaking a full-blown cost benefit analysis. SHINE is used to generate the health system impacts, that are then used as inputs in the CBA*
 - In the future (maybe late 2022) the research team as a first step simply plugs in their scenario changes in HIIC (Health Impact Intervention Calculator) to get HALY, H expenditure and income gain estimates from changing air pollution.

13

13



SHINE-user case study 2

- A research team has spent years quantifying the impact of urban design interventions on air pollution, and thence onto asthma severity, CHD incidence and lung cancer incidence. They want to know for the write up of their study what this might mean for population health impact and how it compares with other public health interventions.
 - *They use SHINE's HIIC, plug in expected disease incidence rate changes relative to BAU (including time lags), and generate HALYs gained by time period*
 - *They then use ANZ-HILT to compare these gains to other interventions, for comparative purposed in the write-up of their paper.*
 - In the future (maybe late 2023) HIIC and ANZ-HILT are interconnected.

14

14



SHINE-user case study 3

- The State Govt / an NGO want to know the health gains and cost effectiveness of 20 preventative interventions. The cover two risk factor domains, and also some risk stratified secondary prevention in primary care.
 - *SHINE-Consulting delivers evaluations for the 20 interventions (possibly working with other academic units with deeper content expertise in domain areas).*

15

15



SHINE-user case study 4

- A clinical and health research team are considering who to target with a screening program in primary care to off more frequent screening for disease X to those with high risk scores. They work with SHINE, using SHINE heterogeneity and 'scaling down' methods to examine differential (cost) effectiveness for age-group and risk strata combinations.

16

16



Case Study 5

A research team is preparing a funding grant. They want to give some indicative idea of the likely health gain to the Australian population, and reduction in health inequalities, from program X they are proposing to test in research. Similar to power calculations, but more about likely population health gain.

17